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The last chapter is devoted to an interesting discussion of the "Conditions of Salt Deposition in Former Geological Periods." In this chapter, and indeed throughout the book, attention is directed to the stratigraphic and paleontologic characteristics of the various types of deposits, the object being to prepare the reader for the stratigraphic chapters which are to follow in Volume II.

The book is a valuable contribution to the science of salt deposits, and should prove of great service to students of economic geology.

W. T. B.

Upper Cretaceous Floras of the Eastern Gulf Region in Tennessee, Mississippi, Alabama, and Georgia. By E. W. Berry. United States Geological Survey, Professional Paper 112, Washington, 1919.

The bulk of the flora is from the Tuscaloosa formation, and this paper is devoted principally to its elucidation and is to be regarded as a preliminary report, because Professor Berry's work was of a reconnaissance nature. Later, when the abundant workable clays of the Tuscaloosa formation are developed for economic purposes, many new localities of fossil plants probably will be discovered and additional representatives of its flora. One hundred and fifty-one species, representing eighty-seven genera from the Tuscaloosa formation, are described. The three other subdivisions of the Upper Cretaceous, the Eutaw formation, the Selma chalk, and the Ripley formation, contributed but meagerly to Berry's collection.

In comparing the Tuscaloosa flora with the European Upper Cretaceous floras, Berry finds that eighteen identical species are found in the European Cenomanian, two in the Turonian, and four in the Senonian. Therefore, the evidence of the floras is overwhelmingly in favor of the pre-Senonian and pre-Montana age of the Tuscaloosa and allied floras. Thirty Tuscaloosa species are found in the Atane beds of Greenland, and ten in the Patoot beds of the same island. The book is amply illustrated with plates.

A. C. N.

The Mineralization of the Copper Shales. By F. Beyschlag. Zeitschrift für praktische Geologie. January, 1921. Pp. 1–16.

In this article Dr. Beyschlag brings forward very cogent arguments in support of the view that the famous copper deposits of Mansfield, Germany, are not of sedimentary origin, but are younger than the rocks which inclose them and where deposited by solutions from magmatic sources and later enriched through the agency of descending solutions.

The copper ores occur in three positions: First, in the highly bituminous and pyritic beds of the copper shale (*Kupferschiefer*); second, in the immediately underlying Zechstein conglomerate and the Weissliegende—the latter forming the upper, bleached portion of the Rotliegende; third, in "rucken" or veins cutting any or all of these Permian sediments.

The dominant metallic minerals in all three situations are chalcopyrite, bornite, and chalcocite. Minor components are pyrite, galena, niccolite, safflorite ($CoAs_2$), and some others. In the copper shale the ore is mainly the so-called "Speise," a fine dust of sandlike ore particles in the rock. Strings and thin plates of sulphides also occur usually parallel to the bedding but elsewhere cutting it at small angles or uniting to form networks of sulphides. Bean and kidney-shaped masses of sulphides also occur. The microscope shows clearly that these sulphides have developed by replacement of the shales. Nowhere are the sulphide masses rounded as might be expected if they were original components of a mechanical sediment. In the Zechstein conglomerate and Weissliegende the ore minerals characteristically form "sand ore" 1–3 cm. thick immediately beneath the copper shale. In the sand-ore spaces between the sand grains are occupied by chalcopyrite and more rarely bornite and chalcocite. Heavy impregnations grade into mere sprinklings of sulphides. In more clayey beds segregations and platelike masses of sulphides occur. The "rucken" or veins occupy faults of a few centimeters to 100 meters displacement cutting the sediments. Many of them are richly mineralized while others are lean or barren. The maximum mineralization of the veins is in the vicinity of the copper shale and frequently the ore is confined to that part of the vein between the displaced portions of the copper shale. Two generations of ore minerals are recognizable in the veins, the older generation with nickel and cobalt arsenides, calcite, molybdenite, and rarely pitchblende, and the younger generation with copper sulphides and barite.

If it is assumed that the ores in the copper shale and Zechstein were deposited on the sea bottom at the time these sediments were laid down, it is necessary to assume that copper-bearing solutions were contributed to the sea by streams from the land or by submarine springs. The land areas of that period contained no rocks which by weathering or otherwise can be supposed to have yielded copper-rich solutions. If submarine springs had been the source of copper-bearing solutions the ores in the sediments should presumably have been less uniform over wide areas than is actually the case.

The author of the paper turns therefore to igneous sources for an explanation of the ores. He points out that the Permian intrusive rocks of Europe are very generally copper-bearing and attributes the primary deposition of copper in the Mansfield deposits to solutions coming from the same magmatic source that at an earlier period yielded the eruptive rocks that form part of the Rotliegende. Cupriferous mineralizing solutions, according to Beyschlag, ascended along the vein fractures and spread laterally through and beneath the copper shale depositing chalcopyrite in the sediments by the filling of pores and by replacement, the bitumen and pyrite in these beds being instrumental in the ore precipitation. They also deposited chalcopyrite, cobalt, and nickel arsenides, molybdenite and rarely pitchblende in the fault fractures.

The writer points out that mineralization in the copper shale and Zechstein is greatest where veins cutting these formations are numerous and close together.

Although Beyschlag does not emphasize particularly the genetic significance of primary mineral composition, to the reviewer the presence in the veins of cobalt and nickel arsenides, of molybdenite and of pitchblende is highly suggestive of a magmatic origin for the mineralizing solutions.

Of the primary ores developed by the processes just described only remnants now remain. Most of the primary ore minerals have been replaced by the rich copper minerals, bornite and chalcocite, through the agency, Professor Beyschlag believes, of descending meteoric waters—the familiar process of downward sulphide enrichment. As evidence of such enrichment, it is shown that much if not most of the bornite and chalcocite is a replacement of chalcopyrite and drawings are presented showing such replacements. Bornite is characteristically the first mineral to replace chalcopyrite; chalcocite then replaces bornite. Further, there is a marked falling off in the abundance of the rich copper minerals in depth.

Of fundamental importance is the conclusion that the ores in the sediments and in the veins were formed contemporaneously, a conclusion based mainly on the restriction of ore in the veins to the vicinity of the ore-bearing beds and conversely the greater development of ore in the beds where they are cut by numerous and close-spaced veins.

E. S. BASTIN